Technical Article

Urban arborization in public pathways of four cities in east Mato Grosso do Sul (MS) Brazil[1]

FREDERICO AUGUSTO GUIMARÃES GUILHERME[2]*, MICHELLY CRISTINA SILVA[2], DANIELLA NOGUEIRA MORAES CARNEIRO[3], HELLEN CRISTINA ALVES NASCIMENTO[2], KAILA RESSEL[2], WENDY CARNIELLO FERREIRA[4]

ABSTRACT

The study of urban arborization can generate great contributions to urban planning, mainly for new and fast-growing cities. Aiming quantifying and qualifying urban arborization in Cassilândia, Chapadão do Sul, Costa Rica and Paranaíba, in Mato Grosso do Sul State, Brazil, we performed a survey of tree species present in 30 blocks of each city. All trees were evaluated regarding tree size, planting site, pruning and physical conservation status. The species were classified native or exotic. There were 3180 individuals and 89 species, with the highest abundance of Brazilian native trees (69%), although the richness of exotic species was higher (78%). Chapadão do Sul had the largest individuals number and Paranaíba, the smallest. The diversity index was low for all cities, especially because of the large number of oitizeiros (*Licania tomentosa*) registered, totaling more than half of the trees surveyed. The widespread use of only one species, as found for the oitizeiro in this study, is not recommended because it reduces diversity and increases the chances of diseases and pests in trees in the urban environment. However, it was observed a high incidence of species used in urban arborization, and tree maintenance aspects, such as pruning, were satisfactory in the four studied cities.
Keywords: *Licania tomentosa*, urban trees in Central Brazil, urban silviculture and landscaping, urban trees.

RESUMO

Arborização urbana em vias públicas de quatro cidades no leste de Mato Grosso do Sul (MS), Brasil

O estudo da arborização urbana pode gerar grandes contribuições ao planejamento urbano, principalmente para cidades novas e com crescimento acelerado. Visando quantificar e qualificar a arborização urbana em Cassilândia, Chapadão do Sul, Costa Rica e Paranaíba, em Mato Grosso do Sul, realizamos um levantamento das espécies arbóreas presentes em 30 quadras de cada cidade. Todas as árvores foram avaliadas quanto ao porte arbóreo, local do plantio, poda e estado físico de conservação. As espécies foram classificadas em nativas ou exóticas. Foram amostrados 3180 indivíduos e 89 espécies, com maior abundância de árvores nativas do Brasil (69%), embora a riqueza de espécies exóticas tenha sido maior (78%). Chapadão do Sul teve o maior número de indivíduos e Paranaíba, o menor. O índice de diversidade foi baixo para todas as cidades, especialmente por causa do grande número de oitizeiros (*Licania tomentosa*) registrados, totalizando mais da metade das árvores levantadas. O uso generalizado de uma espécie, como constatado para o oitizeiro nesse estudo, não é recomendável, pois reduz a diversidade e aumenta as chances de doenças e pragas em árvores no meio urbano. Entretanto, foi observado uma elevada incidência de espécies utilizadas na arborização urbana, sendo que aspectos de manutenção das árvores, como a poda, foram satisfatórios nas quatro cidades estudadas.
Palavras-chave: *Licania tomentosa*, arborização urbana no Brasil Central, silvicultura e paisagismo urbanos, árvores urbanas.

1. INTRODUCTION

Trees are characteristic features of the urban landscape and have a decisive influence on the welfare of urban populations (GONÇALVES and ROCHA, 2009). Historically, they have been closely related to the architecture of cities, and although Brazilian historical material on arborization is scarce, it is known that cultural differences in Brazil have provided different urban models. Planning for arborization is fundamental for urban development and requires, firstly, that the existing scenario be known through a quali-quantitative inventory, as well as to know the biology of plants that can potentially be used (COLETTO et al., 2008).

The fragility and complexity of urban planning require actions that maximize the functions of arborization and reduce costs both for the population and the public administration. Technical and scientific concerns have increased over the last two decades, motivating some specific works, which have produced new knowledge on the behavior of species in urban areas (KURIHARA et al., 2005; SILVA FILHO et al., 2005).

DOI: http://dx.doi.org/10.14295/oh.v24i2.1137

[1]Received in 19/12/2017 and accepted in 10/07/2018

[2] Universidade Federal de Jataí (UFJ), Unidade Acadêmica Especial de Ciências Biológicas, Jataí-GO, Brazil. *Corresponding author: fredericoagg@gmail.com

[3] Universidade Federal do Paraná, Setor de Ciências Agrárias, Departamento de Fitotecnia e Fitossanitarismo. Curitiba-PR, Brazil.

[4] Universidade Federal de Jataí (UFJ), Unidade Acadêmica Especial de Ciências Agrárias, Jataí-GO, Brazil.

Survey and diagnosis of urban arborization can generate great contributions to urban planning. Many techniques have been disseminated for the correct implantation, monitoring and maintenance of arborization (LIMA NETO and BIONDI, 2012). However, it is still common that few tree species represent the majority of individuals in urban arborization, even though it is not recommended (RODOLFO JÚNIOR et al., 2008; GONÇALVES and ROCHA, 2009). This trend was observed in some cities of Mato Grosso do Sul, Brazil, such as in Chapadão do Sul (PELEGRIM et al., 2012) and Campo Grande, the state capital (PESTANA et al., 2011).

In this sense, the objective of this study was to characterize qualitative and quantitatively the arborization of public roads in four cities in the eastern state of Mato Grosso do Sul State: Cassilândia, Chapadão do Sul, Costa Rica and Paranaíba.

2. MATERIAL AND METHODS

The study was carried out in four municipalities located in the eastern mesoregion of Mato Grosso do Sul State, Brazil: Cassilândia, Chapadão do Sul, Costa Rica and Paranaíba, with about 20,966, 19,648, 19,695 and 40,192 inhabitants, respectively (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2012).

The data of urban arborization were collected in 2012 and adapted from the methodology used by Barros et al. (2010). Thus, the sample unit adopted was the city block, standardizing for the study, that was constituted of four sides, predominantly found in all four municipalities. For each city, 30 blocks, independently of the neighborhood, were randomly selected, totaling 120 sampled blocks, where were recorded all woody plants and palm trees present on the sidewalks. Specific literature was used for species identification, in addition to comparison with Herbarium vouchers. The species were classified into families according to the Angiosperm Phylogeny Group (APG IV, 2016). The names and authorship of the species were checked on the Tropicos® website.

To evaluate differences in plant diversity among the four cities, we used the Shannon diversity index (H›), assessing significance by the Hutcheson *t* test at 5% significance. Comparisons were made in pairs between the four cities, in a total of six combinations. In order to compare the observed diversity with the maximum expected, the Pielou evenness index (J') was used, which refers to the distribution pattern of the individuals among the species, with a value equal to 1, referring to the maximum uniformity.

Based on the characteristics of each species, these were categorized as small trees, up to 6m high, and medium to large, with a height of more than 6m. It is worth remembering that in this first category (< 6 m), some species were typically registered with shrubby lifeform, but during the survey they were being driven as saplings trees. The planting site was also registered, whether in private places such as residences, commerce or industry, and even if planted in public places such as schools, churches or hospitals. Regarding to the origin, the trees were classified as exotic or native to Brazil. The species were also classified as fruit plants if they were suitable for human use.

Trees were visually assessed for physical damage with respect to the general state of the plants by assigning a scale of scores, based on Backes et al. (2011), with modifications: 1. sound tree, without signs of physical damage (good); 2. intermediate conditions of vigor and health (satisfactory), and 3. advanced tree decline with severe physical damage (bad). They were also classified for pruning, according to the following description (*sensu* VOLPE-FILIK et al., 2007 and BACKES et al., 2011): 1. none: no traces of any type of pruning; 2. correct: regular pruning or ornamental pruning, adorned with various configurations. Reduction of size for suitability to urban equipment, such as electricity and telephone network; 3. incorrect: excessive branching, altering the typical structure of the tree, or trees with a V- or L-shaped canopy; 4. radical: trees with abrupt cuts or completely cut, with total removal of the crown.

3. RESULTS AND DISCUSSION

The survey recorded 3,180 trees, belonging to 89 species and 40 botany families. The four cities studied (Cassilândia, Chapadão do Sul, Costa Rica and Paranaíba) showed respectively 838; 1,130; 657 and 555 trees (Table 1). This is a satisfactory density in relation to the size of the sample, when it is denoted the arborization in the urban perimeter of cities. For Rocha et al. (2004) the high species number found in surveys indicates an interference of the local population, who carries out continuous and random plantings.

Table 1. Values of density, richness and diversity of species recorded in four cities in Mato Grosso do Sul (MS), Brazil.

	Cassilândia	Chapadão do Sul	Costa Rica	Paranaíba	Total
Number of individuals	838	1130	657	555	3180
Species number	48	54	47	45	89
Diversity (H')	0.96 c	2.19 a	2.07 a	1.79 b	2.08
Eveness (J')	0.25	0.54	0.53	0.45	0.45
Fruit trees density	28	17	33	36	114
Number of fruit species	10	10	10	16	22

Different letters indicate significant differences in diversity, by the Hutcheson *t* test.

Although, in the four cities studied, a high number of individuals were recorded, the diversity index (H '= 2.08) was low. Significantly higher diversity indexes were observed in CO and CH, while CA showed the lowest diversity (Table 1). Other studies with urban arborization in São Paulo State found higher diversity indexes, varying from 2.6 to 3.9 (BORTOLETO et al., 2007; ROSSATTO et al., 2008). However, in Brazilian cities, the low variety of planted species still prevails (PELEGRIM et al., 2012). The low diversity found in the study can be explained by the high number of oitizeiros (*Licania tomentosa*) recorded in all cities. There were 1,876 oitizeiros (59% of total recorded), representing 85% in CA, 36% in CH, 57% in CO and 66% in PA (Table 2). Several studies show the predominance of oitizeiros in inventories of Brazilian cities, varying from 12% to 90% of the total number of trees planted in urban arborization, such as in Chapadão do Sul, Mato Grosso do Sul State (PELEGRIM et al., 2012), Quirinópolis, Goiás State (BATISTEL et al., 2009), Jataí, Goiás State (BARROS et al., 2010), Americana, São Paulo State (SILVA et al., 2009), Jerônimo Monteiro, Espirito Santo State (SILVA et al., 2012) and São João Evangelista, Minas Gerais State (BRANDÃO et al., 2011). Therefore, the use of the species is much higher than that proposed by Santamour Júnior (2002), who recommends no more than 10% of the same species, 20% of some genus and 30% of a botanical family.

Table 2. Species list, in decreasing order, of total abundance in the urban arborization of four cities in Mato Grosso do Sul, Mato Grosso do Sul State, Brazil: Cassilândia (CA), Chapadão do Sul (CH), Costa Rica (CO) and Paranaíba (PA).

Scientific name	CA	CH	CO	PA	Origin	Tree size
Licania tomentosa (Benth.) Fritsch	710	415	381	370	N	M/L
Sapindus saponaria L.	-	230	2	-	N	M/L
Murraya paniculata (L.) Jack.	6	150	19	7	E	S
Myroxylon peruiferum L. F.	-	75	-	-	N	M/L
Schinus molle L.	1	63	5	4	E	M/L
Pachira aquatica Aubl.	8	9	34	10	N	M/L
Ficus benjamina L.	4	8	24	5	E	M/L
Ficus clusiifolia Schott	9	1	30	1	E	M/L
Roystonea oleracea (Jacq.) O.F. Cook	-	30	-	4	E	M/L
Tibouchina granulosa (Desr.) Cogn.	-	12	21	-	E	M/L
Phoenix roebelinii O' Brien	7	2	3	18	E	S
Terminalia catappa L.	6	-	14	9	E	M/L
Poincianella pluviosa (DC.) L.P. Queiroz var. *pluviosa*	5	3	9	11	N	M/L
Lagerstroemia indica L.	1	12	9	4	E	M/L
Juniperus virginiana L.	-	5	2	18	E	M/L
Mangifera indica L.	7	4	9	4	E	M/L

Table 2. cont.

Tabebuia pentaphylla Hemsl.	3	17	-	-	E	M/L
Citrus limonia Osbeck	5	-	4	9	E	S
Erythrina indica Lam. var. *picta* Hort.	-	3	7	6	E	M/L
Tabebuia chrysotricha (Mart. *ex* A. DC.) Standl.	3	3	3	6	N	M/L
Syagrus oleracea (Mart.) Becc.	-	7	-	6	N	M/L
Dillenia indica Blanco	11	-	2	-	E	M/L
Ficus benjamina var. *variegata* L.	2	3	5	3	E	M/L
Bauhinia variegata L.	3	5	4	-	E	M/L
Schefflera arboricola Hayata	-	-	-	11	E	S
Psidium guajava L.	4	2	-	5	N	S
Ficus sp.1	2	5	3	-	E	M/L
Thevetia peruviana (Pers.) K. Schum.	-	-	9	-	E	S
Dypsis lutescens H. Wenddl.	1	1	6	1	E	M/L
Malpighia emarginata Sessé & Moc. Ex Dc.	2	3	3	1	E	S
Ligustrum lucidum W.T. Aiton	-	8	1	-	E	M/L
Anacardium occidentale L.	2	-	2	4	E	M/L
Annona squamosa L.	3	-	2	2	E	M/L
Allamanda catartica L.	-	1	4	2	N	S
Nerium oleander L.	1	4	2	-	E	S
Eugenia uniflora L.	1	1	4	1	N	S
Spathodea campanulata Seem	1	3	2	-	E	M/L
Cycas circinalis L.	1	-	4	1	E	M/L
Callistemon viminalis (Sol. *ex* gaertn.) G. Don *ex* Loud.	1	5	-	-	E	M/L
Mussaenda alicia Hort.	-	2	1	3	E	S
Cassia fistula L.	1	-	1	3	E	M/L
Annona muricata L.	1	2	-	1	E	M/L
Jacaranda mimosaefolia D. Don	-	-	4	-	E	M/L
Michelia champaca L.	4	-	-	-	E	M/L
Syzygium cumini (L.) Skeels	2	1	-	1	E	M/L
Caesalpinia pulcherrima (L.) Sw.	-	1	2	-	E	S
Cassia fistula L. x *cassia javanica* L.	-	2	-	1	E	M/L
Leucaena leucocephala (Lam.) R. De Wit	-	-	2	1	E	M/L
Morus nigra L.	-	-	3	-	E	M/L
Syzygium malaccense (L.) Merr. & L.M. Perry	-	-	1	2	E	M/L
Spondias purpurea L.	-	-	1	1	N	M/L
Schefflera actinophylla (Endl.) Harms	-	-	-	2	E	M/L
Tecoma stans (L.) Juss. Exkunth	1	-	-	1	E	S
Myrocarpus frondosus Allemão	-	-	-	2	E	M/L
Persea americana Mill	1	1	-	-	E	M/L
Hibiscus rosa-sinensis L.	1	1	-	-	E	S
Azadirachta indica A. Juss	2	-	-	-	E	M/L

Table 2. cont.

Muntingia calabura L.	1	-	-	1	E	M/L
Averrhoa carambola L.	-	-	1	1	E	M/L
Beaucarnea recurvata Lem.	2	-	-	-	E	S
*Cedrella fissilis*Velozo	-	1	1	-	N	M/L
Archontophoenix alexandrae var. *beatriceae* (F. Muell.) C.T. White *ex* L.H. Bailey	-	-	1	-	E	M/L
Sabal maritima (H.B.& K.) Burret	-	1	-	-	E	M/L
Tabebuia roseo-alba (Ridl.) Sand.	-	1	-	-	N	S
Bixa orellana L.	-	-	-	1	E	S
Cordia abyssinica R. Br.	1	-	-	-	E	M/L
Quisqualis indica L.	1	-	-	-	E	S
Cordiaeum variegatum (L.) A. Juss.	-	-	1	-	E	S
Jatropa curcas L.	1	-	-	-	E	S
Calliandra brevipes Benth.	-	1	-	-	N	S
Calliandra cf. *inaquilatera* Rusby	-	-	-	1	E	S
Delonix regia (Bojer *ex* Hook.) Raf.	1	-	-	-	E	M/L
Inga edulis Mart.	-	1	-	-	N	M/L
Mimosa caesalpiniifolia Benth.	-	-	1	-	N	M/L
Tamarindus indica L.	-	-	-	1	E	M/L
Cinnamomum zeylanicum Ness.	-	1	-	-	E	M/L
Lechytis pisonis Cambess.	-	-	1	-	N	M/L
Lagerstroemia speciosa Pers.	1	-	-	-	E	M/L
Punica granatum L.	-	1	-	-	E	S
Toona ciliata M. Roem.	1	-	-	-	E	M/L
Artocarpus heterophyllus Lam.	-	1	-	-	E	M/L
Ficus sp.2	1	-	-	-	E	M/L
Moringa oleifera Lam.	1	-	-	-	E	M/L
Myrciaria cauliflora (Mart.) O. Berg	-	-	-	1	N	M/L
Eriobotrya japonica (Thunb.) Lindl.	-	1	-	-	E	M/L
Citrus sinensis (L.) Osbeck	-	1	-	-	E	S
Citrus reticulata L.	-	-	-	1	E	S
Cestrum sp	-	1	-	-	N	S
Solanum paniculatum L.	-	1	-	-	E	S

Origin (E: exotic / N: native of Brazil). Tree size (S: small; M/L: medium/large).

Although 22 fruit species were found in the survey, only 3.6% comprised the total sampled individuals (Table 1). However, this result was superior to that found by Rossatto et al. (2008) in Assis, São Paulo State, Brazil, which found 0.5% of the total of individuals distributed in eight fruit species. According to Rocha et al. (2004) the presence and the variety of fruit trees planted on the sidewalks may indicate the participation of the local population in the arborization, as a desire to create an urban garden. Fruit species provide food for humans, generate some benefits for the local community, such as the possibility of harvesting fruits on the sidewalks, as well as enhancing the attraction of small animals, especially birds (CARVALHO et al., 2010). Although the use of fruit trees in urban arborization is not advisable, as some species may foul public roads and serve as food for vectors of diseases, such as flies, rats and cockroaches.

Other species showed high densities in the arborization of the four cities studied (Table 2). In Cassilândia, besides *Licania tomentosa*, *Ficus clusiifolia* (1.0%) and *Dillenia*

indica (1.3%); in Chapadão do Sul, *Sapindus saponaria* (20.3%), *Murraya paniculata* (13.2%) and *Myroxylon peruiferum* (6.7%); in Costa Rica, *Paquira aquatica* (5.1%), *Ficus clusiifolia* (4.5%) and *Ficus benjamina* (3.6%); and in Paranaíba *Juniperus viginiana* (3.2%), *Phoenix roebelenii* (3.2%) and *Schefflera arboricola* (2.0%). This high abundance of *Sapindus saponaria* used in the arborization of Chapadão do Sul was responsible for the great proportion of Cerrado native plants in this city.

Of the total trees sampled in the study, 22% are composed of exotic trees, while 69% and only 9% are distributed in native plants to Brazil and Cerrado, respectively. However, of the 89 species recorded, 78% are exotic, 16% are native to Brazil and only 6% are native to Cerrado (Table 3). Our findings are similar to other studies, where usually there is a greater proportion of exotic species than native ones (BORTOLETO et al., 2007; MIRANDA and CARVALHO, 2009; SILVA et al., 2008). The widespread use of alien species in urban arborization is undesirable, whereas may have impacts on biodiversity and regional decharacterization (STUMPF et al., 2015). On the other hand, the greater abundance of native species in the present study is notorious and important, since it favors the preservation of endangered native species and maintains the cultural customs of the region, such as medicinal and culinary use. In addition to these aspects, the use of native species can facilitate the establishment of seedlings and reduce maintenance costs of city arborization, considering that these are better adapted to the environmental conditions of the region's origin. They can also, in general, play a fundamental role in the supply of food for the native animals (SANTOS et al., 2011), even in the urban perimeter of the cities. Even though present with lower density and plant richness in the current study, the use of native Cerrado species in urban arborization is recommended, although information on its use in cities is still scarce. Tree seedlings in southwest of Goiás, a region bordering the cities studied in Mato Grosso do Sul, have shown that ingás (*Inga* spp), ipês (*Tabebuia* spp and *Handroanthus* spp) and canafístula (*Peltophorum dubium*) increase satisfactorily. Therefore, among several other tree native species, they are indicated for use.

Table 3. Richness (S) and density (D) in relation to the species origin (exotic or native of Brazil) used in urban arborization in four cities in Mato Grosso do Sul (MS), Brazil.

Cities	Exotic		Native		Total	
	S	D	S	D	S	D
Cassilândia	40	90	8	748	48	838
Chapadão do Sul	39	345	15	785	54	1130
Costa Rica	36	147	11	510	47	657
Paranaíba	35	132	10	423	45	555

Among of the 3,180 registered trees, 80% were planted in front of the residences, 14% in other public places, such as churches, schools and day care centers. Only 6% of the trees were registered in front of commercial establishments, which may be related to the greater visibility of the forefront and the lack of planning and control of the municipality. According to Ferreira et al. (2009) the small tree number in front of commercial establishments shows the lack of planning in these places and their preference in highlighting the forefront. In addition, in general there is no retreat of the built-up areas, which also prevents the implantation of trees in these places.

Of the total trees registered in the study, 44% were free and 56% under electric wiring, of which 10% showed conflicts. A similar result was found by Miranda and Carvalho (2009), where 10% of the trees presented conflicts with wiring in Ponta Grossa, Paraná State. In Pombal, Paraná State, Brasil there was interference of up to 50% of trees in the electrical network in several neighborhoods studied (RODOLFO JÚNIOR et al., 2008). In general, these conflicts are related to the planting of large size species under the wiring, without planning and pruning of maintenance. According to Gonçalves and Rocha (2009) and Silva et al. (2008), the contact of the trees in the electricity wiring generally worries all the energy distribution companies, due to the incompatibility between the arborization and elements of the urban road. Usually this is due to the lack of planning, and often the trees are pruned without the technical support. According to PIRES et al. (2007), the most efficient procedure would be the planting of small size species under the electric and telephone network. However, many specialists have recommended that electric and telephone networks should be designed so as not to conflict with larger trees.

Regarding to the trees physical condition in the four cities studied, 81% (2,558 trees) showed good conditions, 17% (531 trees) satisfactory condition and 2% (61 trees) bad maintenance conditions (Figure 1-A). Similar results were recorded by Batistel et al. (2009) when comparing two neighborhoods of Quirinópolis, Goías State, Brazil, which found that the majority (between 73 and 89%) of the trees planted were in good conditions. Regarding to pruning, 75.4% of the trees sampled were pruned correctly, 10% incorrect, 12% non-existent and 2.6% drastic (Figure 1-B). Volpe-Filik et al. (2007) and Miranda and Carvalho (2009) recorded the highest number of trees with drastic pruning in Piracicaba, São Paulo State and Ponta Grossa,

Paraná State, Brazil, respectively. A different result was found by and Rocha (2009) in Vila Maria, São Paulo State, Brazil, with 58.5% of the individuals sampled with drastic pruning. We can note that the pruning quality and trees maintenance are directly related, therefore, with similar results recorded. This reinforces the importance of good pruning, and even more important, of knowing which tree species to plant in a given site.

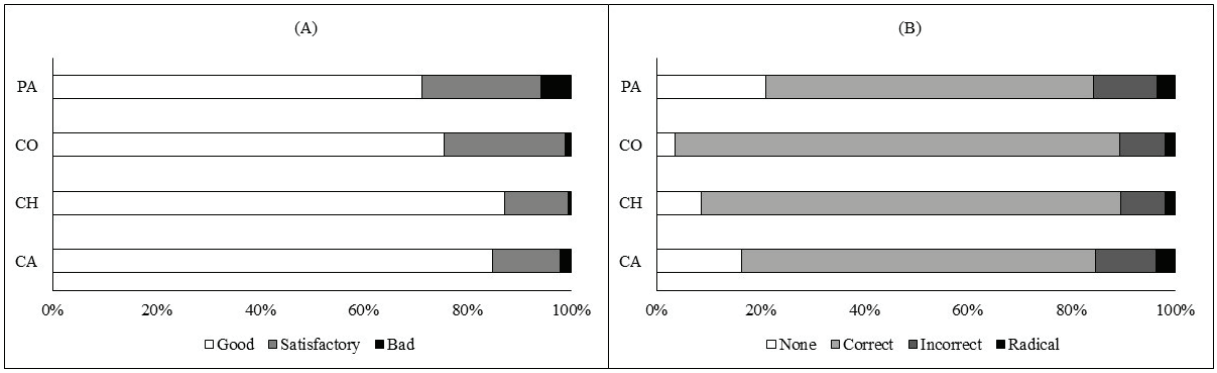

Figure 1. Physical aspects of damage (A) and pruning features of trees (B) in four cities in Mato Grosso do Sul, Mato Grosso do Sul State: Cassilândia (CA), Chapadão do Sul (CH), Costa Rica (CO) and Paranaíba (PA).

4. CONCLUSIONS

In the four studied cities of the east of Mato Grosso do Sul State, Brazil, 89 species were sampled. Although with a high richness, in general, were registered low species diversity, mainly due to the homogenization of the urban arborization, characterized by the predominance in the use of oitizeiros. However, in general, there is a high incidence of plants used in the arborization of the studied cities, and the raised trees presented pruning and satisfactory physical conservation aspects.

ACKNOWLEDGMENTS

The authors would like to thank the National Council for Scientific and Technological Development (CNPq) by granting the scholarship to MC Silva and PQ-2 (Process Nº 303159/2015-4) to FAG Guilherme.

AUTHORS CONTRIBUTION

F.A.G.G.: data analysis and interpretation, manuscript preparation and review. **M.C.S.**: data collection and analysis, manuscript preparation. **D.N.M.C.**: manuscript preparation and critical review. **H.C.A.N.**: data collection. **K.R.**: manuscript preparation and critical review. **W.C.F.**: manuscript preparation and critical review.

REFERENCES

APG IV. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. **Botanical Journal of the Linnean Society**, v.181, p.1-20, 2016.

BACKES, F.A.A.L.; GIRARDI, L.B.; NEUHAUS, M.; BELLÉ, R.A.; SCHWAB, N.T.; PEITER, M.X. Caracterização das espécies utilizadas na arborização urbana em Silveira Martins, RS. **Revista Brasileira de Horticultura Ornamental**, v.17, n.2, p.167-174, 2011.

BARROS, E.F.S.; GUILHERME, F.A.G.; CARVALHO, R.S. Arborização urbana em quadras de diferentes padrões construtivos na cidade de Jataí. **Revista Árvore**, v.34, n.2, p.287-295, 2010.

BATISTEL, L.M.; DIAS, M.A.B.; MARTINS, A.S.; RESENDE, I.L.M. Diagnóstico qualitativo e quantitativo da arborização urbana nos bairros Promissão e Pedro Cardoso, Quirinópolis, Goiás. **Revista da Sociedade Brasileira de Arborização Urbana**, v.4, n.3, p.110-129, 2009.

BORTOLETO, S.; SILVA FILHO, D.F.; SOUZA, V.C.; FERREIRA, M.A.P.; POLIZEL, J.L.; RIBEIRO, R.C.S. Composição e distribuição da arborização viária da estância de águas de São Pedro-SP. **Revista da Sociedade Brasileira de Arborização Urbana**, v.2, n.3, p.32-46, 2007.

BRANDÃO, I.M.; GOMES, L.B.; SILVA, N.C.A.R.; FERRARO, A.C.; GONÇALVES, F.G. Análise quali-quantitativa da arborização urbana do município de São João Evangelista-MG, **Revista da Sociedade Brasileira de Arborização Urbana**, v.6, n.4, p.158-174, 2011.

CARVALHO, J.A; NUCCI, J.C; VALASKI, S. Inventário das árvores presentes na arborização de calçadas da porção central do bairro Santa Felicidade, Curitiba/PR. **Revista da Sociedade Brasileira de Arborização Urbana**, v.5, n.1, p.126-143, 2010.

COLETTO, E.P.; MÜLLER, N.G.; WOLSKI, S.S. Diagnóstico da arborização das vias públicas do município de Sete de Setembro, RS. **Revista da Sociedade Brasileira de Arborização Urbana**, v.3, n.2, p.110-122, 2008.

FERREIRA, F.C.; FERREIRA, M.E.G.; CITELI, A.F.T.; MONGE, C.R.; KONRAD, M. Características da arborização urbana de regiões comerciais e residenciais no município de Adamantina, SP. **Omnia Exatas**, v.2, n.2, p.47-53, 2009.

GONÇALVES, S.; ROCHA, F.T. Caracterização da arborização urbana do bairro de vila Maria Baixa. **Revista Científica UNINOVE**, v.2, p.67-75, 2009.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. Available in: <http:// www.ibge.gov.br>. Acessed on: May 19th 2012.

KURIHARA, D.L.; IMANÃ-ENCINAS, J.; DE PAULA, J.E. Levantamento da arborização do campus da UnB. **Revista Cerne**, v.11, n.2, p.127-136, 2005.

LIMA NETO, E.M.; BIONDI, D. The design of sample units for the inventory of urban afforestation in Curitiba city, Paraná State, Brazil. **Revista da Sociedade Brasileira de Arborização Urbana**, v.7, n.4, p.107-117, 2012.

MIRANDA, T.O.; CARVALHO, S.M. Levantamento quantitativo e qualitativo de indivíduos arbóreos presentes nas vias do bairro da Ronda em Ponta Grossa-PR. **Revista da Sociedade Brasileira de Arborização Urbana**, v.4, n.3, p.143-157, 2009.

PELEGRIM, E.A.P.; LIMA, A.P.L.; LIMA, S.F. Avaliação qualitativa e quantitativa da arborização no bairro Flamboyant em Chapadão do Sul, MS. **Revista Sociedade Brasileira de Arborização Urbana**, v.7, n.1, p.126-142, 2012.

PIRES, N.A.M.T.; MELO, M.S.; OLIVEIRA, D.E.; SANTOS, S.X. Diagnóstico da arborização urbana do município de Goiandira, Goiás. **Revista Brasileira de Biociências**, v.5, n.4, p.537-539, 2007.

ROCHA, R.T.; LELES, P.S.S.; OLIVEIRA NETO, S.N. Arborização de vias públicas em Nova Iguaçu, RJ: o caso dos bairros Rancho Novo e Centro. **Revista Árvore**, v.28, n.4, p.599-607, 2004.

RODOLFO JÚNIOR, F.; MELO, R.R.; CUNHA, T.A.; STANGERLIN, D.M. Análise da arborização urbana em bairros da cidade de Pombal no estado da Paraíba. **Revista da Sociedade Brasileira de Arborização Urbana**, v.3, n.4, p.3-19, 2008.

ROSSATTO, D.R.; TSUBOY, M.S.F.; FREI, F. Arborização urbana na cidade de Assis-SP: uma abordagem quantitativa. **Revista da Sociedade Brasileira de Arborização Urbana**, v.3, n.3, p.1-16, 2008.

SANTAMOUR JÚNIOR, F.S. **Trees for urban planting:** diversity unifomuty and common sense. Washington: U.S. National Arboretum, Agriculture Research Service, 2002. 66p.

SANTOS, C.Z.A.; FERREIRA, R.A.; SANTOS, L.R.C. Composi**ção** florística de 25 vias **públicas de Aracaju, SE. Revista da Sociedade Brasileira de Arborização Urbana**, v.6, n.2, p.125-144, 2011.

SILVA FILHO, D.F.; PIVETTA, K.F.L.; COUTO, H.T.Z. Indicadores de floresta urbana a partir de imagens aéreas multiespectrais de alta resolução. **Scientia Forestalis**, v.67, n.1, p.88-100, 2005.

SILVA, A.G.; CARDOSO, A.L.; RAPHAEL, M. Diagnóstico quali-quantitativo da arborização viária da cidade de Jerônimo Monteiro, ES. **Enciclopédia Biosfera**, v.8, n.14, p.1179-1188, 2012.

SILVA, L.F.; VOLPE-FILIK, A.; LIMA, A.M.L.P.; SILVA FILHO, D.F. Análise da arborização viária em dois bairros de Americana (SP). **Revista Brasileira de Horticultura Ornamental**, v.14, n.2, p.147-158, 2008. DOI: https://doi.org/10.14295/rbho.v14i2.284

STUMPF, E.R.T.; SILVA, P.S.; ROMAGNOLI, I.D.; FISCHER, S.Z.; MARIOT, M.P. Espécies nativas que podem substituir as exóticas no paisagismo. **Ornamental Horticulture**, v.21, n.2, p.165-172, 2015. DOI: https://doi.org/10.14295/aohl.v21i2.663

VOLPE-FILIK, A.; SILVA, L.F.; LIMA, A.M.L.P. Avaliação da arborização de ruas do bairro São Dimas na cidade de Piracicaba/SP através de parâmetros qualitativos. **Revista da Sociedade Brasileira de Arborização Urbana**, v.2, n.1, p.1-10, 2007.